complete the decay equation:

$^{210}_{84}Po \longrightarrow {}^{206}_{82}Pb + {}^{4}_{2}He$

$^{14}_{6}C \longrightarrow {}^{14}_{7}N + {}^{0}_{-1}e + {}^{0}_{0}\bar{\nu}$

electron anti-neutrino

$^{10}_{6}C \longrightarrow {}^{10}_{5}B + {}^{0}_{+1}e + {}^{0}_{0}\nu$

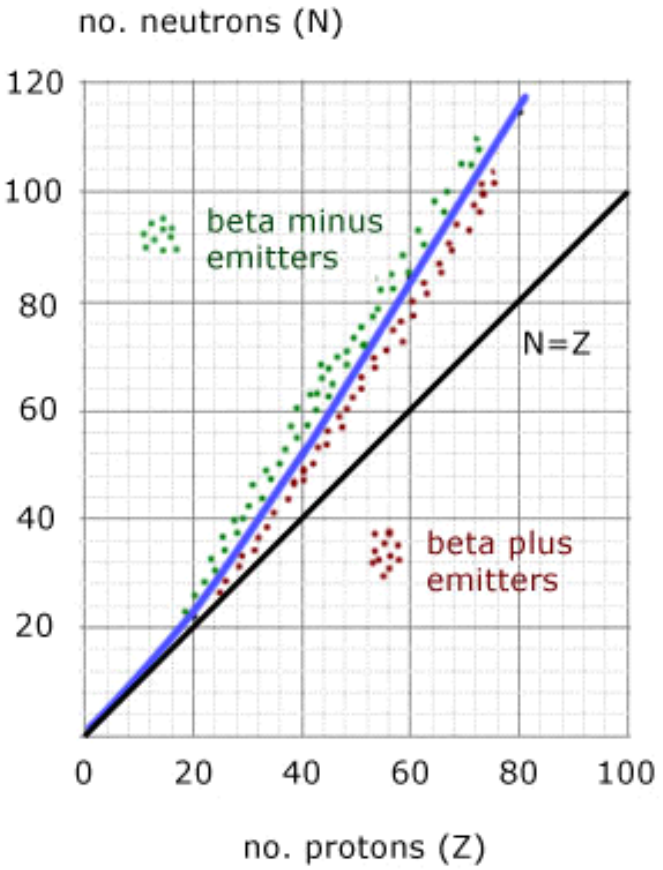
positron neutrino

anti-matter has the same mass as corresponding matter but opposite charge and quantum numbers

Radioactive Half-life

Some Isotopes are unstable and decay.

The decay of any individual nucleus is random. (Quantum randomness)



Nuclear stability

When a graph of neutron number (N) against proton number (Z) graph is plotted for all known nuclides – fig 1 is obtained.

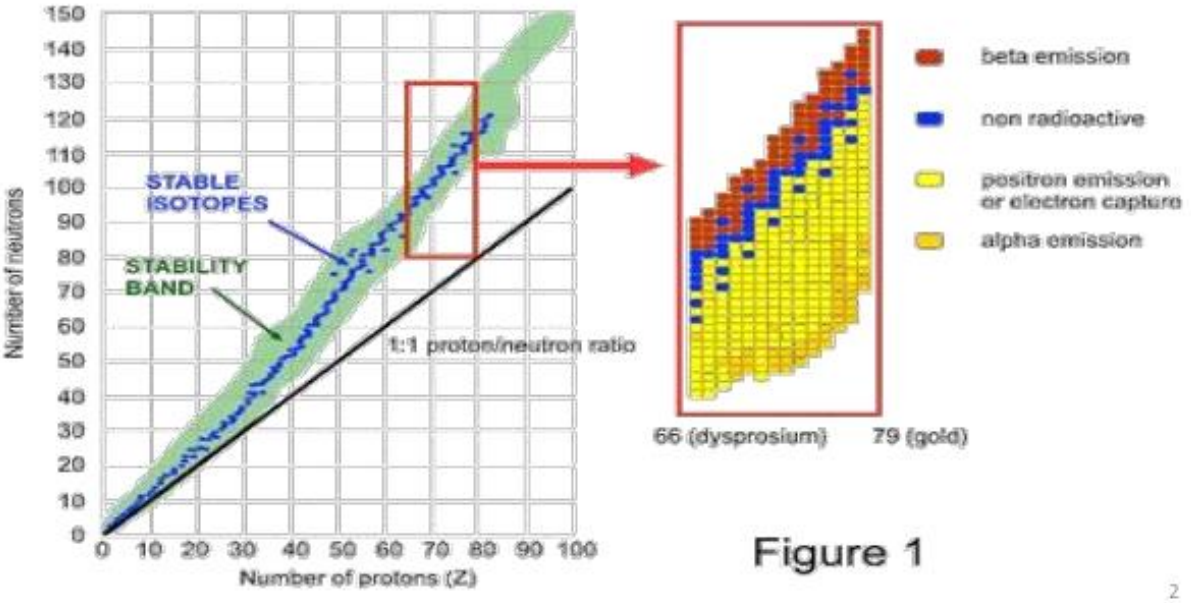


Figure 1

2

Size of the nucleus is calculate by:

$R=R_oA^{1/3}$

p1085 in Hecht
R_o is 1.2fm = 1.2 x 10^{-15}m radius of hydrogen nucleus (hydrogen atom radius = 53pm = 5.3 x 10^{-11}m)
A is atomic mass number
R is the radius of the nucleus

eg. the radius of of carbon 14 nucleus is

$R= 1.2fm \times (14)^{1/3} = 2.4$ fm

the density is roughly equal for all nuclei

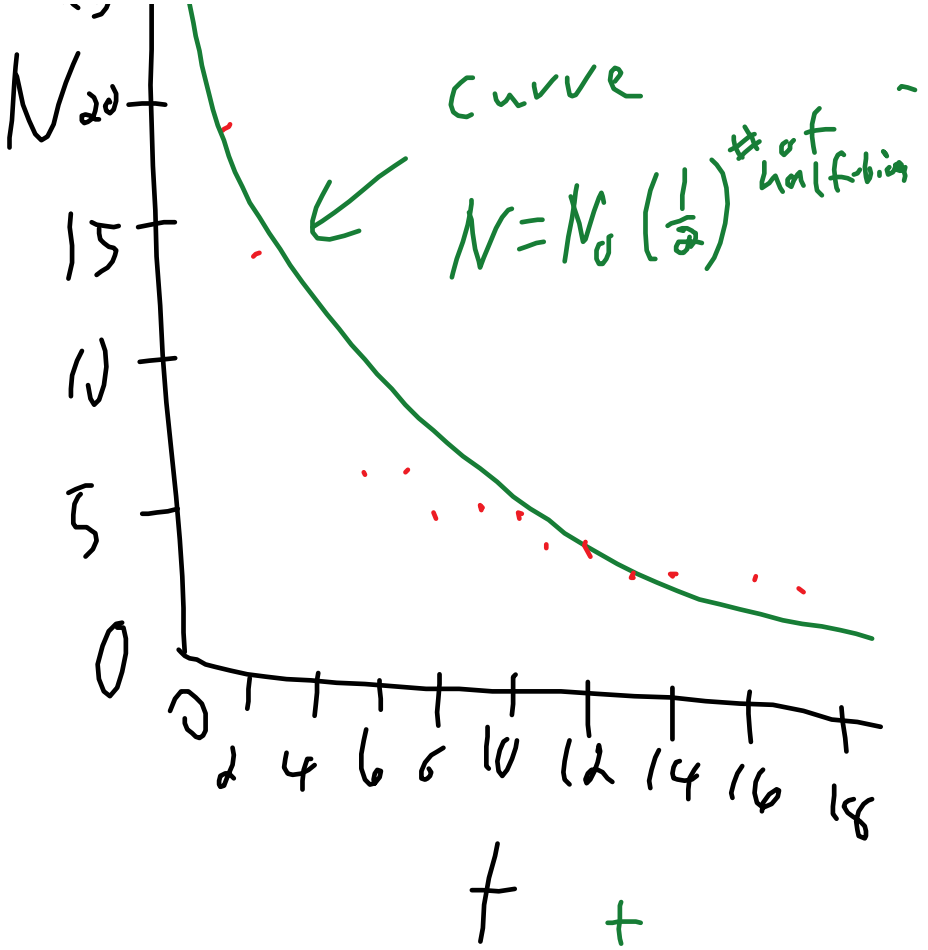
Let's do a model of radioactive decy
Each student has 2 coins, if you flip and get 2 heads, you are a decays nucleus and sit down.

N is the number of undecayed nuclei

N_o is the original number of undecayed nuclei
$t_{1/2}$ is the half-life
λ = the decay constant = natural log of 2 /half-life
= probability of a particular atom decaying in a unit time

N (number of	t (time)

(number of undecayed)	
31	0
25	1
18	2
14	3
11	4
9	5
6	6
6	7
4	8
4	9
4	10
3	11
3	12
2	13
2	14
2	15
2	16
2	17
1	18



$N = N_0 \left(\frac{1}{2}\right)^{\#\text{ of half lives} = \frac{t}{t_{1/2}}}$ equivalent

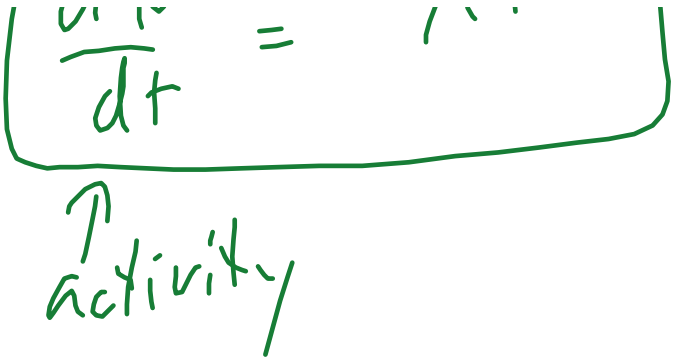
$N = N_0 e^{-\lambda t}$

$\lambda = \frac{\ln 2}{t_{1/2}}$

$\frac{dN}{dt} = -\lambda N_0 e^{-\lambda t}$

or

$\frac{dN}{dt} = -\lambda N$



eg. Carbon 14 has a half-life of 5730 years.

a) what is the decay constant?
b) what is the probability of a particle nucleus decaying in a year?
c) you measure a sample and it has an activity of 3.0 x10^3 decays per second. How many C 14 atoms are in the sample?
d) if the sample is 40 000 years old (3 sig figs), how many atoms were in the original sample?
e) if a sample of C 14 is reduced to 1/32 of the original sample how old is the sample?
f) if a sample of C 14 is reduced to 0.000000123453 of the original sample how old is the sample?

p1116 problems 17, 25, 57, 59, 65, 69

When anti-matter hits equivalent matter it annihilates - changes into energy.

How much energy? $E=mc^2$
c is speed of light, 3.00 x 10^8m/s
When an electron hits a positron (both of

mass 9.11 x 10^{-31}kg) what is the minimum energy of the released photons? Why do I say minimum?

Einstein's miraculous year, 1905
4 papers

1. photoelectric effect
2. Brownian motion
3. special relativity
4. relativistic energy